Abstract:

About 10-15 years ago, platform strategies were introduced into the automotive product development processes (PDP), e.g. Muffatto (1999), to enable a wider variability and flexibility of vehicles at a reasonable cost level. To increase further flexibility to reduce development time/costs and to meet changing customer demands for higher quality and higher individuality, the traditional strategy based on a fixed platform with exchangeable “hats” is not appropriate any more. Hence, the concept of “modularity” is now more and more introduced into the PDPs, e.g. Ishii and Yang (2003). To benefit from the true value of this modularity, a multi-generational perspective considering the real design options for the full vehicle life cycles is required. In 2011, Volkswagen for example started to move the bulk of its volume cars to the MQB architecture (Modularer Querbaukasten = Modular Transverse Toolkit). MQB started in 2011 with the new Audi A3 and it is expected that the MQB platform will include all of VW’s volume (and some smaller premium) offerings in the B, C and D classes (e.g., VW’s Fox, Polo, Golf, Jetta, Beetle, Touran, Eos and Passat; Audi’s A3 and TT; Skoda’s Fabia, 
Roomster, Octavia and Superb; and Seat’s Ibiza, Cordoba, Leon, Altea and Toledo). In this type of modular concept, components can be exchanged in a very flexible manner between the product families to realize scaling effects and reduce drastically development costs. Package parameters (e.g. wheel base distance, aggregate locations) can be chosen freely and the different modules adapt flexible to these changes. Special development tools are required to support the development of these modular concepts, for example the Modular Function Deployment (MFD) or the Generic Process for Toolkit Development (GPTD) discussed in the dissertation of Renner (2007) for the management of variants and complexity at the BMW Group and its suppliers to reduce the inherent risks of modular product development. In addition, today’s vehicle development process is driven by Computer Aided Engineering (CAE), where the functionalities are assessed by virtual simulations for safety, comfort, etc. The corresponding model development, which is normally based on finite element methods (FEM) or multi-body systems (MBS), is still cumbersome and can take several weeks for a single model. A transfer from package geometry to CAD-based representations (Computer Aided Design) and to the CAE fields is required and often still realized more or less manually. Here advanced virtual methods offer a huge potential for reduction of costs and development time. In particular, so-called parameterized techniques are beneficial because they allow the automated adaptation of the models via the modification of the design parameters to the different variants of vehicles. Combined with a specialized library of pre-designed modules, the PDP can be rendered much more efficient than by traditional approaches. In addition, they enable the designers and engineers to apply automated optimization methods to derive the best compromises between all functional requirements. To realize such a parametric modular development, there are two main approaches. The first - for example available via the CAD software CATIA V5/6 - is based on explicit parameterizations, which allow automated variations only when the dependencies of the different components are defined explicitly by the users. This is in general rather cumbersome due to the complexity of modern car architectures. Hence the technique presented here based on the software SFE CONCEPT with its implicit parameterization approach is much better adapted to the requirements of the new modular vehicle PDP. The dependencies between the parts and modules are defined implicitly and do not require that the users to implement them directly. Modifications can therefore be realized easily and in an automated manner. Examples of the new developments for this implicit parameterization approach are presented in this paper focusing on the potential for early concept design. Parameterizations for package, car body and the other modularized groups will be shown together with their usage in automated shape and topology optimization with respect to safety and comfort requirements. In particular, the recent developments in realising efficient module development via automated shape optimization are presented.

Stichworte: Platform design, modularity, implicit parameterization, shape optimization, SFE CONCEPT

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